Paleontological Research, vol. 3, no. 3, pp. 162–172, 5 Figs., September 30, 1999

The turrilitid ammonoid *Mariella* from Hokkaido — Part 2

(Studies of the Cretaceous ammonites from Hokkaido and Sakhalin —— LXXXVI)

TATSURO MATSUMOTO[1] and YOSHITARO KAWASHITA[2]

[1]c/o *Kyushu University 33, Fukuoka 812–8581, Japan*

[2]*2–179, Tomatsu Chiyoda, Mikasa 068–2134, Japan*

Received 23 February 1999; Revised manuscript accepted 26 April 1999

Abstract. The following five taxa of the genus *Mariella* of the Turrilitidae from the Upper Albian and Lower Cenomanian of Hokkaido are described: (1) *M.* (*Mariella*) *bergeri* (Brongniart, 1822), (2) *M.* (*M.*) aff. *bergeri* (Brongniart), (3) *M.* (*M.*) *miliaris* (Pictet and Campiche, 1861), (4) *M.* (*M.*) cf. *carrancoi* (Böse, 1923) and (5) *M.* (*M.*) *gallienii* (Boule, Lemoine and Thévenin, 1907). The present study gives new or revised information as to the taxonomy and stratigraphic occurrences of these species.

Key words: Late Albian–early Cenomanian, *Mariella* (*Mariella*) *bergeri*, *M.* (*M.*) *carrancoi*, *M.* (*M.*) *gallienii*, *M.* (*M.*) *miliaris*

Introduction

In Part 1 Matsumoto *et al.* (1999) described three well defined species of *Mariella* from the Lower Cenomanian of the Soeushinai area (northwestern Hokkaido). In Part 2 we continue to describe some more species (five taxa) from the Upper Albian and Lower Cenomanian of Hokkaido. The material is mostly from the Soeushinai area, except for a supplementary specimen from the Shuparo [=Shuyubari] area of the Yubari Mountains (central Hokkaido).

With respect to the location and stratigraphic assignment of the material from the Soeushinai area, readers may refer to the route maps in the two papers by Nishida *et al.* (1996, figs. 3–5; 1997, fig. 11) and for more information to the locality guide and maps given by Matsumoto and Nishida (1999, figs. 6, 7) as an Appendix to Part 1. The locality in the Shuparo area will be identified more specifically in the description of the species concerned.

The following symbols are used for the repositories of the specimens described in this paper.

GK: Type room, Department of Earth and Planetary Sciences, Kyushu University, Fukuoka

GS: Geological Collections, Faculty of Culture and Education, Saga University, Saga

Palaeontological descriptions

(Continued from Part 1)

Mariella (*Mariella*) *bergeri* (Brongniart, 1822)

Figure 1

Turrilites bergeri Brongniart, 1822, p. 395, pl. 7, fig. 3.

Mariella bergeri (Brongniart). Spath, 1937, p. 510, pl. 57, fig. 28; text-fig. 178; Drushchits, 1960, p. 266, pl. 12, figs. 2, 3; Seyed Emami, 1982, p. 419, pl. 7, figs. 11, 12.

Mariella (*Mariella*) *bergeri* (Brongniart). Chiriac, 1960, p. 6, pl. 1, figs. 10, 11; Klinger and Kennedy, 1978, p. 28, text-fig. 6E (only); Atabekian, 1985, p. 27, pl. 2, figs. 4, 5; pl. 3, figs. 1–11; pl. 4, figs. 1–7; Kennedy, 1996, *in* Gale *et al.*, p. 583, figs. 16o, 28a, b, i, j, l, o, p; 29h, i, m.

Paraturrilites (*Bergericeras*) *bergeri* (Brongniart). Wiedmann and Dieni, 1968, p. 80, pl. 7, fig. 5; pl. 9, figs. 2, 5.

Turrilites (*Bergericeras*) *bergeri bergeri* (Brongniart). Scholz, 1979, p. 40, pl. 8, figs. 12, 14, 15, 17.

Holotype.—The original of *Turrilites bergeri* Brongniart, 1822, pl. 7, fig. 3 (by monotypy).

Material.—GS. G183 (Figure 1-1, 2) collected by Y.K. on 25 September 1995 at loc. R803 and GS. G184 (Figure 1-3) collected by Y.K. and others on 15 August 1996 at loc. R813, both in situ from the upper part of the Member My2, (mudstone with frequently intercalated laminae and beds of sandstone), well exposed on the floor of the Sounnai River (for its location see fig. 6 in Part 1); GK. H8512, a small specimen collected by Jun Aizawa and T.M. on 14 August 1998 at loc. R8005 (close to R803) from a lenticular layer of sandstone in the Member My2.

Description.—Each of the three specimens is a fragmentary whorl of half ammonoid preservation. They can be regarded as representing whorls of roughly successive growth stages. The small, unillustrated GK. H8512 preserves shelly matter, showing small tubercles in four rows at

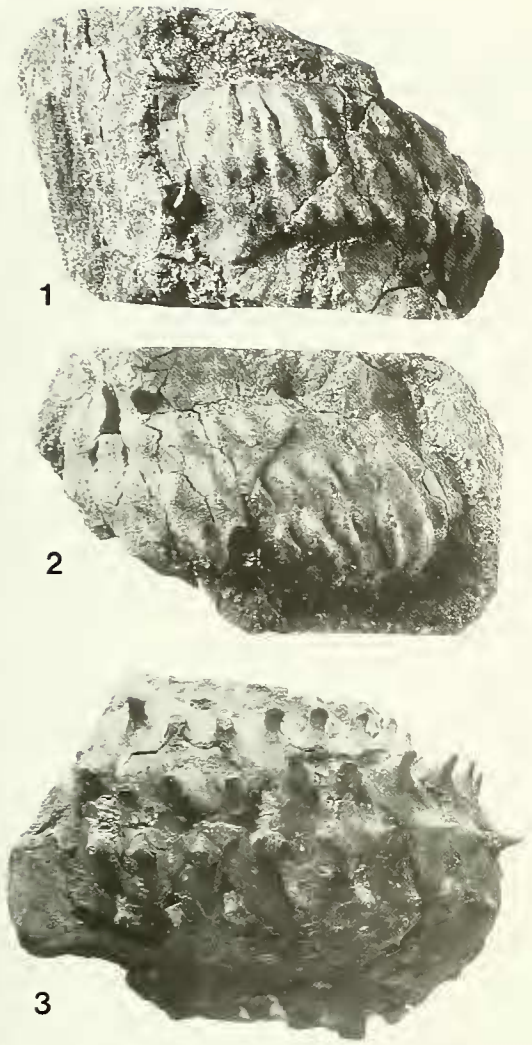

Figure 1. *Mariella* (*Mariella*) *bergeri* (Brongniart). **1.** GS. G183, slightly oblique, lateral view showing the sedimentary structure of the host rock in the left part, ×1. **2.** GS. G183, upside-down lateral view, showing the whole part of the preserved flank, ×1.2. **3.** GS.G184, upside-down lateral view, ×1. (Photos by N. Egashira without whitening.)

subequal intervals. The tubercles are connected by weak ribs.

GS. G183, about 22 mm in height, is somewhat deformed. It shows three rows of transversely elongated tubercles at equal intervals on the flank. The tubercles are aligned obliquely on weak ribs. Eleven tubercles are counted on the exposed part of the flank, showing ornamentation of moderate density. There is an extra tubercle in the upper row, but it is finer and its upwardly extended rib is faint (see the upper left part of Figure 1-1 or the lower right part of Figure 1-2). As the specimen is an abraded internal mould, the tubercles are not pointed. The tubercles of the fourth row are not exposed on the flank.

GS. G184 is comparatively large, 32 mm in whorl height and 65 mm in diameter. It is in a nodule and slightly deformed. Shell material is preserved for the most part. The exposed whorl face is subrounded, with a broadly convex main flank and a well rounded upper shoulder. The tubercles are in four rows. They are uniformly spinose and conical at their base. The three rows on the main flank are equidistant; the fourth row is closer to the third at the base. The heads of the spines are, however, nearly equidistant, since the first spine extends obliquely upward, the second laterally, the third slightly downward and the fourth vertically downward (see Figure 1-3, in which the whorl is set upside down). The tubercles are connected transversely by low ribs in sowewhat oblique orientation and those of the first row extend upward to the ribs. Some of the ribs appear to be doubled between the tubercles of adjacent rows.

Comparison.—The small specimen (GK. H8512) is comparable with a young specimen illustrated by Atabekian (1985, pl. 3, fig. 1). The second specimen (GS. G183) is comparable with a middle-aged whorl of a figured example (*e.g.*, Atabekian, 1985, pl. 4, fig. 6). The third specimen (GS. G184) is roughly as large as the preserved last whorl of such examples as figured by Scholz (1979, pl. 8, figs. 12, 14, 15), but the uniform spinosity of its ornamentation seems to be peculiar. It should be noted, however, that on a portion of this specimen where the shell layer is stripped off, there are no spines and the tubercles are expressed as transversely elongated elavations like those of GS. G183.

Judging from the above observations, the described specimens can be identified with *M.* (*M.*) *bergeri*, although they are incomplete.

Occurrence.—As for material. The upper part of the Member My2 is regarded as the uppermost Albian (Nishida *et al.*, 1996, p. 93; Matsumoto and Nishida, 1999, p. 116).

Discussion.—Klinger and Kennedy (1978, p. 28, pl. 7, figs. C, D; text-fig. 7A) have recorded *M.* (*M.*) cf. *bergeri* from the "Lower Cenomanian I" of Zululand (South Africa). It shows a lower apical angle and its lower three rows of tubercles are according to those authors equidistant. It is possibly an example of *M.* (*M.*) *dorsetensis* (Spath) from South Africa, whereas "*M.* (*M.*) *dorsetensis*" of Klinger and Kennedy (1978, p. 31, pl. 7, fig. F; text-figs. 3A, 8A) is certainly *M.* (*M.*) *lewesiensis* (Spath).

Mariella (*Mariella*) *acanthotuberculata* Klinger and Kennedy (1978, p. 30, pl. 7, figs. C, D; text-fig. 7A), from the "Lower Cenomanian II" of Zululand, has spinose tubercles in four rows on every whorl, but its ribs and tubercles are relatively coarser and less numerous than those of our specimen (GS. G184). Moreover, it shows a higher apical angle (50°-60°) and it is different in whorl shape from any example of *M.* (*M.*) *bergeri*, for its whorls show a quadrate section and a much lower ratio of height to diameter. Incidentally, the described specimens of *M.* (*M.*) *acanthotuberculata* are tiny but beautifully preserved. Here again the spinosity is finely shown when the shell is well preserved.

Mariella* (*Mariella*) aff. *bergeri (Brongniart, 1822)

Figures 2 ; 3-1

Material.—A single specimen, GS. G185 (Figure 2), collected by Y.K. on 29 June 1992 from one of the boulders (p4) at loc. R520 of the East Suribachi-zawa (for the location see Matsumoto and Nishida, 1999, fig. 6). It was probably derived from the basal part of the Member My3. *Graysonites adkinsi* Young was obtained from another boulder at R520.

Description.—Shell is of moderate size, about 140 mm in tower height (total whorl height, including the inferred missing portion) and 55 mm in diameter of the last septate whorl. The rate of size increase between successive whorls is moderate, maintaining a value of 1.37. The apical angle is estimated at 42°. The ratio between whorl height and diameter in the septate stage is constant at 0.43 (see Table 1).

The exposed part of the whorl face is rounded in gross view. In more detail, a nearly flat but narrow space is recognized in the uppermost part of the whorl face. This slopes down gradually to the convex main flank, which then slopes down inward toward the lower whorl seam. The whorl junction is thus deep and well marked. The siphuncle runs along the midline of the uppermost flat belt.

Despite the regular shell shape in the septate stage, the last part (*i.e.*, the body chamber) of this specimen is much distorted and curved upward. This aberrant shape is similar to that in certain species of *Eubostrychoceras* Matsumoto, 1967. However, whether it is an original character or a product of secondary deformation cannot be decided from this single specimen.

There are three rows of tubercles on the exposed whorl face. The first row is somewhat above the middle of the flank, the second row is well below the midline and closer to the third row, which in turn runs slightly above or nearly along the lower whorl seam. These three rows tend to shift downward with growth. The tubercles of the fourth row are not observable from the outside. They probably lie on the unexposed lower whorl face. The tubercles increase in number with growth, from 24 in the preserved young whorl to 34 in the last septate whorl. Those of the two rows on the main flank are moderately coarse and strengthen with growth. The tubercles in the first row extend upward to

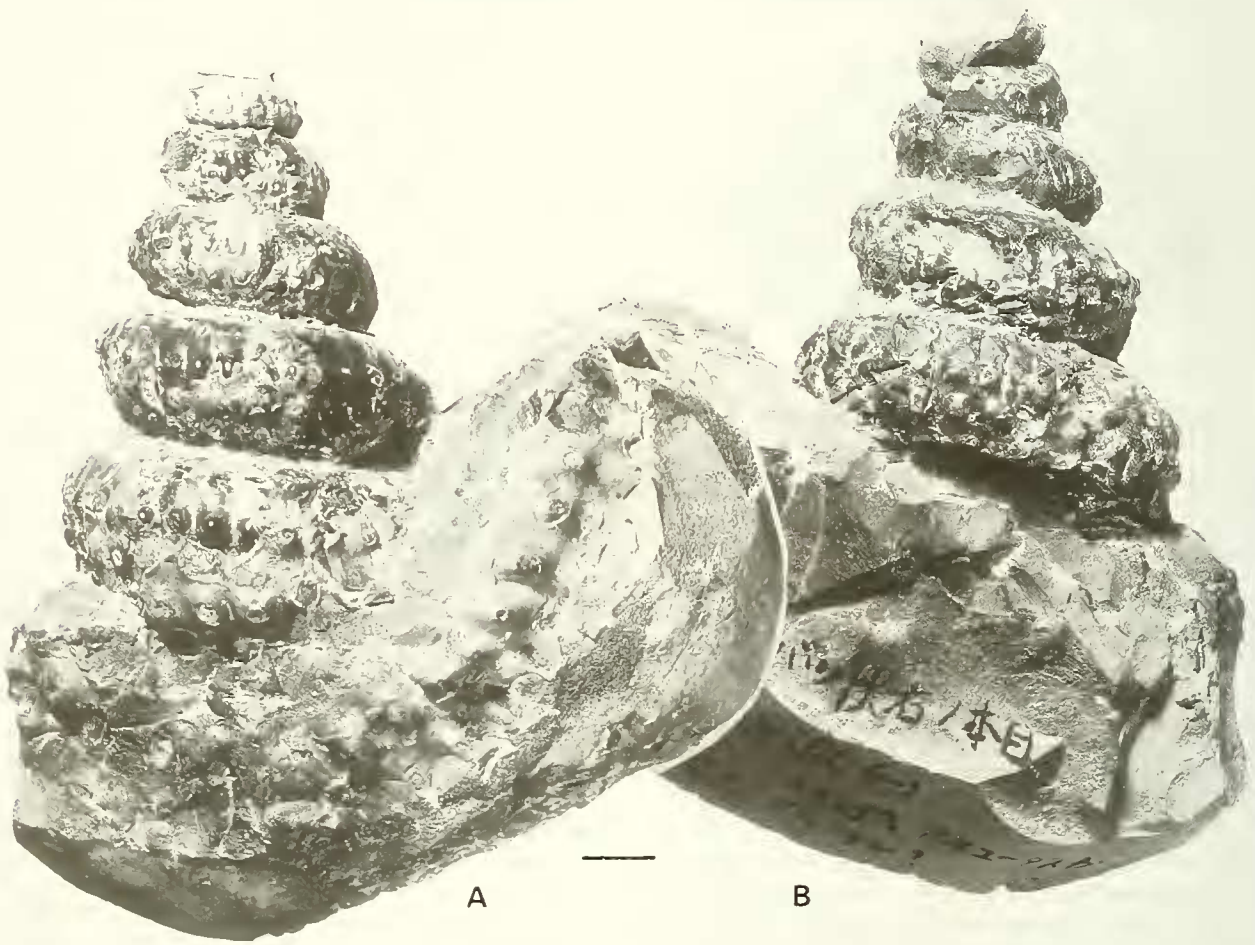

Figure 2. *Mariella* (*Mariella*) aff. *bergeri* (Brongniart). GS. G185, two lateral views, in which A is turned 180° to B, ×1. (Photos by N. Egashira without whitening.)

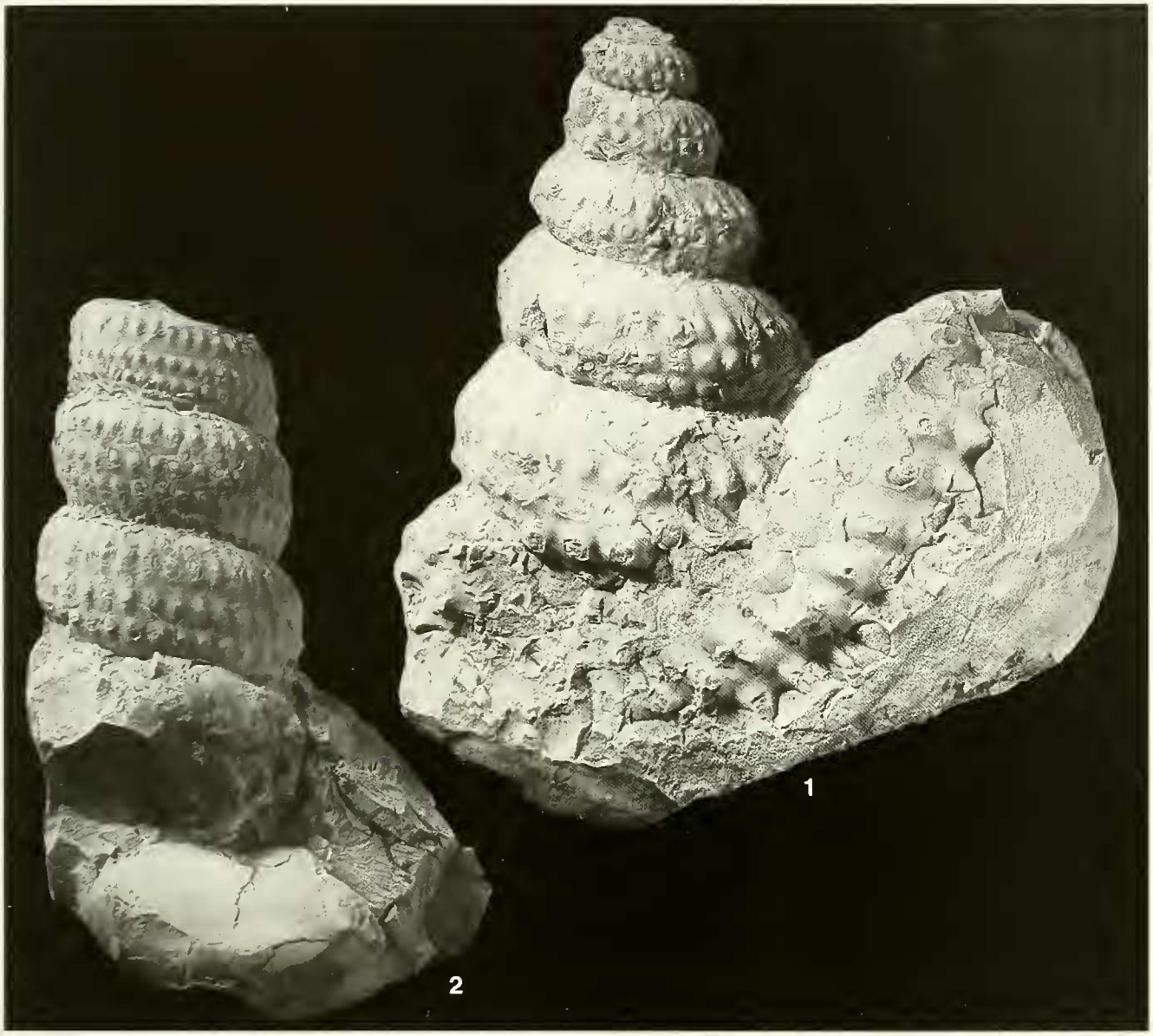

Figure 3. **1.** *Mariella* (*Mariella*) aff. *bergeri* (Brongniart). GS. G185, lateral view, ×1.1. **2.** *Mariella* (*Mariella*) *miliaris* (Pictet and Campiche). GS. G186, lateral view, ×1.1. (Photos by N. Egashira with whitening.)

form distinct ribs which fade away onto the uppermost flat belt. The tubercles of the second row are conical and become slightly larger than those of the first row with growth. On the body chamber the tubercles of these two rows strengthen and become spinose. The spines of the tubercles in the second row are much elongated and sharply pointed terminally.

The suture is observable here and there, although it is not traced completely.

Measurements.—See Table 1.

Comparison.—In gross view the septate part of this specimen is similar to some specimens of *Mariella* (*Mariella*) *bergeri* (see list of synonymy in the preceding species). The apical

Table 1. Measurements of *Mariella (Mariella)* aff. *bergeri* (Brongniart). Measured specimen: GS. G185 (Figure 2).

Whorl (Order)*	1st	2nd	3rd	4th	5th
Diameter (in mm)	16.5	25.5	35.0	48.0	65.0
Height (in mm)	7.5	11.0	15.0	20.0	28.0
Height/Diameter	.45	.43	.43	.42	.43
Tubercles per whorl	24	26	28	30	33

* The 1st, 2nd, 3rd etc, on the line "Whorl" indicate the descending order of the whorl (=in an adapertural direction) within the preserved part of the specimen.

angle of the former is certainly larger than the average of the latter, but it can be placed at the extreme end of the wide range of variation in the latter. The existence of a flat belt in the uppermost part of the exposed whorl face seems to be particular to this specimen, although the belt is narrow.

The increase in the number of tubercles or ribs per whorl with growth from 24 in youth to 34 in the last septate stage may be characteristic of this taxon. This rib density is between that of *M.* (*M.*) *bergeri* and of *M.* (*M.*) *miliaris* (*vide infra*), but the ribs and tubercles are not so fine as those of *M.* (*M.*) *miliaris*, becoming rather coarser with growth. The strong tubercles on the flank in the adult whorl have prominent spines. This is another diagnostic feature of this specimen. If the ascending feature of the last part of the body chamber were an original character, it could be regarded as another diagnostic feature, but this should be confirmed by additional material.

To sum up, this specimen probably represents an early Cenomanian new species which was derived from typical *M.* (*M.*) *bergeri* of late Albian age. As only a single specimen from a boulder nodule is available, it would be better to call it provisionally *Mariella* (*M.*) aff. *bergeri* (Brongniart).

Occurrence.—As for material.

Discussion.—*Turrilites spinosus* Kossmat (1895, p. 142, pl. 20, fig. 3) [= *Turrilites brazoensis* of Stoliczka, 1866, p. 189, pl. 88, fig. 3, (*non* Roemer, 1852)], from the lower Utatur Group of South India, has four rows of spinose tubercles. The original specimen is a large fragmentary whorl (probably body chamber) on which ribs are often bifurcated at the tubercle and some riblets are irregularly added. Certainly it has no affinity with the present taxon. It might be a *Pseudhelicoceras*, as Breistroffer (1947, p. 44) suggested.

Mariella* (*Mariella*) *miliaris (Pictet and Campiche, 1861)

Figures 3-2; 4-1, 2

Turrilites bergeri Brongniart var. *miliaris* Pictet and Campiche, 1861, p. 136; 1862, pl. 58, fig. 5.

Mariella miliaris (Pictet and Campiche). Spath, 1937, p. 514, pl. 57, figs. 25, 26, text-fig. 179.

Mariella (*Mariella*) *miliaris* (Pictet and Campiche). Chiriac, 1960, p. 456, pl. 1, figs. 14-16; pl. 2, figs. 17-20; Renz, 1968, p. 88, pl. 18, fig. 10; text-figs. 31m, 32h; Förster, 1975, p. 189, pl. 7, figs. 6; Klinger and Kennedy, 1978, p. 29, pl. 3, fig. J, text-fig. 3E; Atabekian, 1985, p. 29, pl. 5, figs. 5-12, pl. 6, figs. 1-3; Wright and Kennedy, 1996, p. 333, pl. 100, fig. 28.

Turrilites (*Bergericeras*) *bergeri bergeri* Brongniart. Scholz, 1979, p. 40 (pars), pl. 9, fig. 1 only.

Holotype.—The original of Pictet and Campiche, 1861, p. 136; 1862, pl. 58, fig. 5 (reillustrated by Renz, 1968, pl. 18, fig. 10) (by monotypy).

Material.—GS. G186 (Figures 3-2 and 4-1), obtained by Y.K. on 16 August 1982 from a transported nodule at loc. R575 of the Suribachi-zawa, probably derived from the Member My3. GS. G187 (half ammonoid preservation) found by Y.K. on 31 July 1997 in a transported nodule at loc. R967 (for the location see Nishida *et al*., 1997, fig. 11) on the upper course of the River Kotanbetsu within the outcropping area of the Member My5. GS.G188 (Figure 4-2) (half ammonoid preservation) obtained by Y.K. on 18 October 1993 from a nodule in the second northern branch rivulet of the Kita-no-sawa, a tributary of the River Shuparo in the Yubari Mountains. It is inferred to have been derived from one of the Members Mc to Me of Kawabe *et al*. (1996, p. 449, fig. 4-3). These members correspond to units IIc and IId of Matsumoto (1942) and are referred to the lower part of the Cenomanian.

Description.—The three specimens are moderately large. They preserve several whorls. GS. G186 consists of four slightly distorted whorls with a low ratio of increase in diameter. Hence, the apical angle appears to be acute, although whorls of earlier growth stages are not preserved. In the two other specimens of middle to late growth stages, the ratio of increase in diameter is slightly larger than the above and the estimated apical angle would be about 25°, provided that their original total whorl height (=tower height) was about 200 mm.

The exposed whorl face is semielliptical, although the main part of the flank is less convex in GS. G186 in comparison with the two others. The contact between whorls is moderate, showing an impressed junction.

Tubercles in four rows are moderately crowded and numerous, 36 per whorl in GS. G186 and 17 or 18 to half a whorl in GS. G188. They are disposed regularly; those of the first row are placed some way above midflank and extend upward to the ribs which reach the upper whorl seam with decreasing intensity. The conical tubercles of the second row lie below midflank. The tubercles of the third row are somewhat smaller than the above and appear to be granular. The tubercles of the fourth row lie in the interwhorl junction. They may be somewhat clavate. The tubercles of the three rows on the flank are disposed on an adaperturally displaced line, i.e., an approximate extension of the upper rib. The interval of the three rows on the flank slightly decreases downward. The fourth tubercle lies close to the third and the rib is bent at the lower whorl seam, running on the lower whorl surface with a gentle curvature toward the umbilicus.

The suture is only partly exposed and hardly traced wholly.

Measurements.—See Table 2.

Comparison.—The holotype of this species is a piece of a whorl as shown by a photographic illustration of Renz (1968, pl. 18, fig. 10). It was distinguished as a variety from typical "*Turrilites bergeri*" by finer and denser ornament. Although *M. miliaris* was raised to the status of an independent species by Spath (1937, p. 514), the available material was not ample. More material was added by subsequent authors, especially by Chiriac (1960) from Eastern Europe and by Atabekian (1985) from Western Asia. Thus, it has become clear with time that this species shows a considerable extent of variation in morphological characters.

The number of tubercles (or ribs) in each row is around 36 in our specimens. This is within the range of variation from 33 to 40 in the material of Atabekian (1985, p. 29). The apical angle is recorded as 42° in a British specimen (Wright and Kennedy, 1996, p. 333), whereas it is 35°, 30° and even 25° in some specimens from Western Asia (Atabekian, 1985, p. 29). In this respect the described specimens from Hokkaido can be regarded as examples with a comparatively

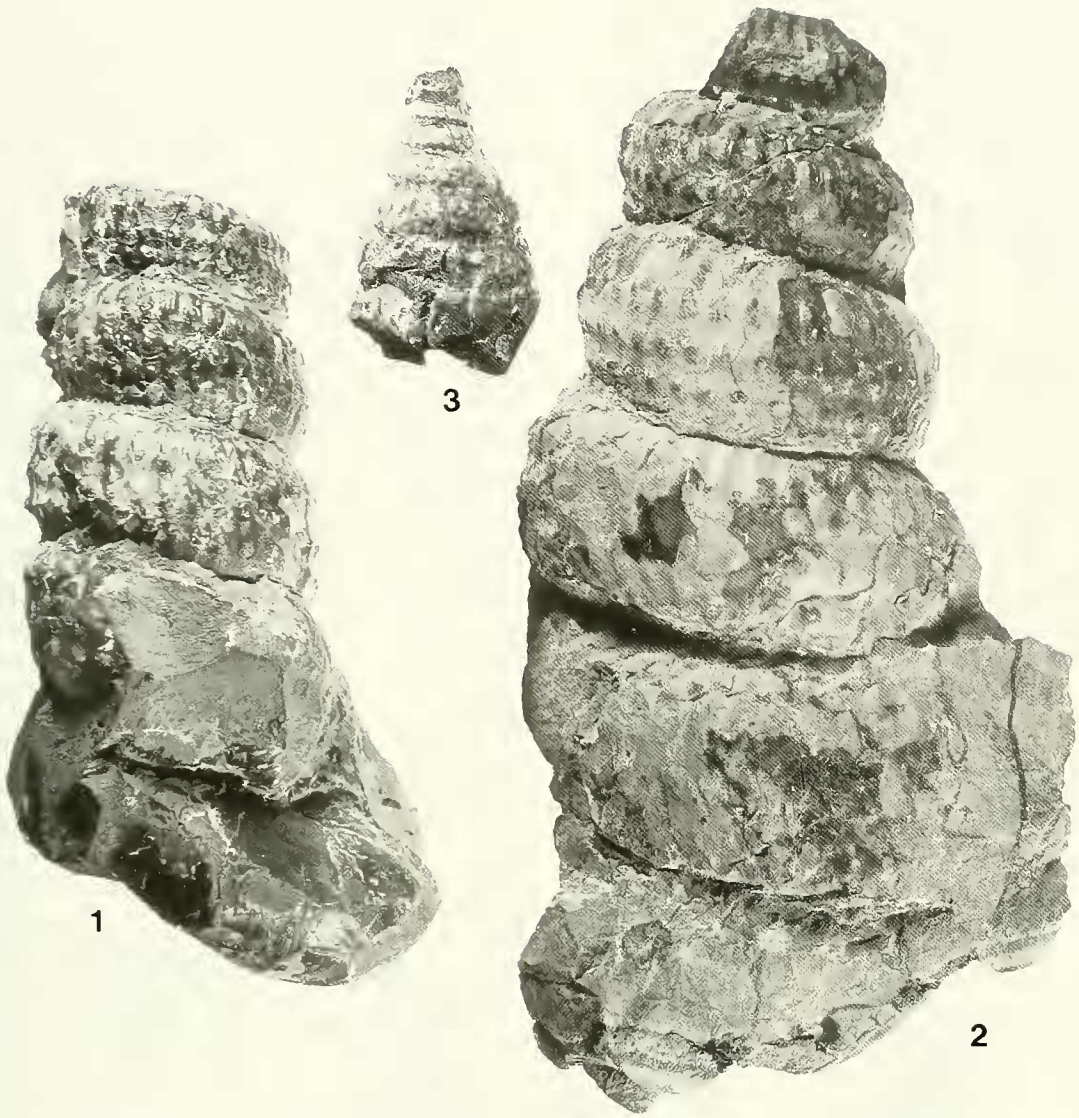

Figure 4. **1, 2.** *Mariella* (*Mariella*) *miliaris* (Pictet and Campiche). **1.** GS. G186, lateral view (90° anticlockwise turned from the view of Figure 3-2), ×1. **2.** GS. G188, lateral view, ×1. **3.** *Mariella* (*Mariella*) cf. *carrancoi* (Böse). GK. H8507, lateral view, ×1.5. (Photos by N. Egashira without whitening.)

smaller apical angle within the range of this species.

Hitherto described specimens of this species from various regions of the world are rather small. Most of them are not adult. In fact, the two specimens figured by Atabekian (1985, pl. 5, fig. 5; pl. 6, fig. 1) appear to exemplify whorls of younger stages which can be succeeded developmentally by specimens such as ours which are of middle to late growth stages.

The largest of the whorls measured by Atabekian (1985, p. 29) is 50 mm in diameter, but in GS. G188 (Figure 4-2) from Hokkaido the diameter of the whorl preceding the last is 62 mm. The last whorl (i.e., body chamber) of this shell is deformed, but it has an eroded remnant of the rostrum and, thus, represents an adult shell.

Occurrence.—As for material.

Discussion.—The relationship between *M.* (*M.*) *bergeri* and *M.* (*M.*) *miliaris* has been discussed by previous authors. Morphologically and also stratigraphically they are intimate. They cannot be distinguished by the difference in apical angle, since the extent of variation in the angle is great in both species.

The proportion of the height (H) to diameter (D) of a whorl is fairly constant in our specimens, 0.46 to 0.48 (see Table 2). This is the same as that of the holotype, in which D=37.5, H=18.0, H/D=0.48 on the basis of Renz' (1968, pl. 18, fig. 10) illustration. A similar value can be estimated for the whorls of many, if not all, of the illustrations of less deformed specimens of *M.* (*M.*) *bergeri* (e.g., Renz, 1968, pl. 18, figs. 3, 4;

Table 2. Measurements of *Mariella* (*Mariella*) *miliaris* (Pictet and Campiche).

Whorl (Order)*	1st	2nd	3rd	4th
Measured specimen : GS. G186 (Figure 4-1)				
Diameter (in mm)	31.0	35.2	39.2	44.0
Height (in mm)	14.2	16.8	18.7	—
Height/Diameter	.46	.48	.48	—
Tubercles per whorl	36	36	36	35
Measured specimen : GS. G188 (Figure 4-2)				
Diameter (in mm)	42.0	52.6	~60.0	—
Height (in mm)	19.5	25.2	28.0	31.5
Height/Diameter	.46	.48	.47	—
Tubercles/half whorl	17	18	~17	—

*: as for Table 1. ~: apporoximate

Atabekian, 1985, pl. 2, figs. 4, 5 ; pl. 3, fig. 9). This is another feature that shows the resemblance between the two species.

A sole distinction between the two species is in the ornamentation, namely finer, denser and more numerous ribs and tubercles in *M.* (*M.*) *miliaris* in comparison with *M.* (*M.*) *bergeri*. In both species, however, there is a considerable variation even in this. The number of tubercles to a whorl is recorded to extend from 33 to 54 in *M.* (*M.*) *miliaris* against 25 to 30 in *M.* (*M.*) *bergeri*. Thus, the extent of variation in the number of tubercles appears to be continuous between the two taxa. A statistical examination would give a clear solution of the problem.

Stratigraphically *M.* (*M.*) *miliaris* has been recorded from the Upper Albian *dispar* Zone in many cases, but in England it is reported also from the Lower Cenomanian (Wright and Kennedy, 1996, p. 333). Our present material suggests, if not clearly indicates, the occurrence in the lower part of the Cenomanian in Hokkaido.

Mariella* (*Mariella*) cf. *carrancoi (Böse, 1923)

Figure 4-3

Compared.—
Turrilites carrancoi Böse. 1923, p. 147, pl. 10, figs. 25-31.
Turrilites multipunctatus Böse, 1923, p. 154, pl. 10, figs. 48-58.
Mariella (*Mariella*) *carrancoi* (Böse). Clark, 1965, p. 44, pl. 13, figs. 1-4, 7, 10.

Lectotype.—IGM. 1076-C, figured by Clark, 1965, pl. 13, fig. 3 (designated by Clark, 1965, p. 44).

Material.—GK. H8507 (Figure 3-3) and GK. H8508-H8511 from a transported nodule collected by Nishida and others on 20 August 1988 at loc. R449 of the upper reaches of the Suribachi-zawa (for the location see Matsumoto and Nishida, 1999, fig. 6). The nodule is inferred to have been derived from the Member My3 from its location and lithology, although the sandstones and mudstones in thin-bedded alternation like those of the Member My2 crop out narrowly between R456 and R460.

Description.—The specimens are more or less incomplete ; six whorls are preserved in GK.H8507, three in H8508, two in H8509, slightly over one in H8510 and only one in H8511. They are small ; the largest one, H8507, is about 30 mm in tower height and 17 mm in diameter of the last whorl. The apical angle is 43° in H8507 and H8508 but maybe somewhat more acute in H8509. The whorl is subquadrate in section with a trapezoidal flank. The ratio of height to diameter in each whorl is very low, about 0.33 to 0.35 in H8507 and H8508, but it varies to some extent with growth and also between individuals (e.g., 0.42 in H8509). Whorls are tightly coiled and their junction is deep.

The main part of the flank is ornamented by two rows of relatively coarse tubercles, with an apparent spiral groove between them. This feature is more pronounced on young whorls where these tubercles show nodular protuberances and are apparently crowded. The tubercles of the third row are disposed along the lower whorl seam. Those of the fourth row are on the lower whorl face and concealed by the succeeding whorl, unless the basal surface is exposed. The number of tubercles per whorl is 24 to 27. Ribs are scarcely discernible on the younger whorls, but on later whorls the tubercles of the first row extend shortly upward in riblike fashion, the tubercles of the second row are somewhat transversely elongated as if connected with the tubercles of the third row, which in turn give rise to radial ribs on the lower face. The tubercles of the fourth row are tiny and each rests on a rib. This feature is observable partly in GK. H8508 and impressed on the upper surface of GK. H8509.

Suture (E/L saddle and L) is partly discernible on the flank of the middle-aged whorl in GK. H8507.

Comparison.—The above-described specimens are rather peculiar to Japan, but they are well comparable with *M.* (*M.*) *carrancoi* (Böse), from the "Vraconian" of Zacatecas, Mexico, redefined by Clark (1965, p. 44, pl. 13, figs. 1-4, 7, 10). Although the absence of ribs is taken as a character of this species by Clark and also by Klinger and Kennedy (1978, p. 31), this is applied to the flank ornament of rather earlier growth stages. At least the riblike extension is observable even in the illustration of the lectotype (Clark, 1965, pl. 13, fig. 3) and more elongated ribs are discernible on the whorl of later growth stages in other specimens (e.g., Clark, 1965, pl. 13, figs. 1, 7 and 10). Even in our specimens the mode of lighting, especially its orientation, gives dissimilar appearances to this character. Some of the figures by Böse (1923, pl. 10, figs. 25-31, 48-58) show variation in the ornament between individuals and also with growth. The low ratio between whorl height and diameter is another diagnostic character of this species. The lectotype, measured on the illustration (Clark, 1965, pl. 13, fig. 3), gives 0.31, 0.32, 0.40 and 0.42 in accordance with growth. Our specimens fall in the same ratio range.

To sum up, a set of specimens from loc. R449 can be almost certainly identified with *Mariella* (*Mariella*) *carrancoi* (Böse, 1923). However, the five specimens have some deficiencies in preservation. It would be better to call them tentatively *M.* (*M.*) cf. *carrancoi*, until material of better preservation is obtained from rocks of a definite stratigraphic level.

Occurrence.—As for material. It should be noted that the present material is inferred to have been derived from the Member My3 of early Cenomanian age, whereas *M.* (*M.*) *carrancoi* has been reported to occur in the upper part of the

Albian of Zacatecas, Mexico. The species may range across the Albian-Cenomanian boundary. This should be examined in future.

Mariella* (*Mariella*) *gallienii (Boule, Lemoine and Thévenin, 1907)

Figure 5

Turrilites puzosianus d'Orbigny var. *gallienii* Boule, Lemoine and Thévenin, 1907, p. 40, pl. 7, figs. 4, 4a, 4b, 5, 5a.
Turrilites gallienii Boule, Lemoine and Thévenin. Collignon, 1931, p. 89, pl. 9, figs. 15, 16.
Paraturrilites gallienii (Boule, Lemoine and Thévenin). Collignon, 1964, p. 12, pl. 320, figs. 1379, 1380.
Mariella (*Mariella*) *gallienii* (Boule, Lemoine and Thévenin) *evoluta* Klinger and Kennedy, 1978, p. 29, pl. 3, figs. C, H, I; pl. 6, figs. B, D, O; pl. 7, figs. A, B; text-figs. 1E; 4E-G.
Mariella (*Mariella*) *gallienii gallienii* (Boule, Lemoine and Thévenin). Wright and Kennedy, 1996, p. 333, pl. 98, figs. 2, 3, 25, 27; text-fig. 134, D. E, L.

Lectotype.—The original of Boule, Lemoine and Thévenin, 1907, pl. 7, figs. 4, 4a, 4b, from the Cenomanian of Diégo Suarez, northeastern Madagascar (designated by Wright and Kennedy, 1996, p. 333).

Material.—GS. G189 (Figure 5-1), GS. G190 (Figure 5-2, 3), GS. G191 (Figure 5-4), GS. G192 (half ammonoid preservation) and GS. G193 (fragmentary), collected by Y.K. and N. Egashira on 21 June 1996 from a nodule contained in the mudstone of the Member My3 at loc. R906 of the Hoteizawa, Soeushinai area (for the location see fig. 7 in Part 1).

Description.—GS. G189 consists of two tightly coiled whorls, although the earliest part is unpreserved. Its whorl is subrounded in cross section, with a broadly convex main part of the flank which passes across the abruptly rounded shoulder to the narrow upper face and likewise downward to the gently convex lower surface. The estimated apical angle is high (60°). The ornament of this specimen consists of numerous, densely disposed, weakly oblique ribs on which small tubercles are set in four rows at subequal intervals. The ribs start at the upper whorl seam and run across the upper shoulder to the main part of the flank and further across the lower shoulder to the basal surface. The ribs are thus continuous, but they slightly weaken at the interspaces of the three tubercles, resulting in two shallow spiral depressions on the flank (Figure 5-1a, b). The tiny fourth tubercles are discernible on the basal surface where ribs run to the umbilical margin with a gentle curvature (Figure 5-1c).

The three specimens, GS. G190-G192, show a tall turreted shape, consisting of several (4 to 6) whorls. They seem to show an apparently low apical angle, but the actual apex is not known, because several whorls of the youngest stage are not well shown. The whorls are rather loosely coiled in the main to later growth stages and the last one (body chamber) is detached in GS. G191 (Figure 5-4), although this feature might be secondary. It should be noted that the whorls in earlier stages seem to be fairly tightly coiled (Figure 5-2, 3, 4). In the young stage of these specimens the whorl shape is fairly similar to that of the above small specimens

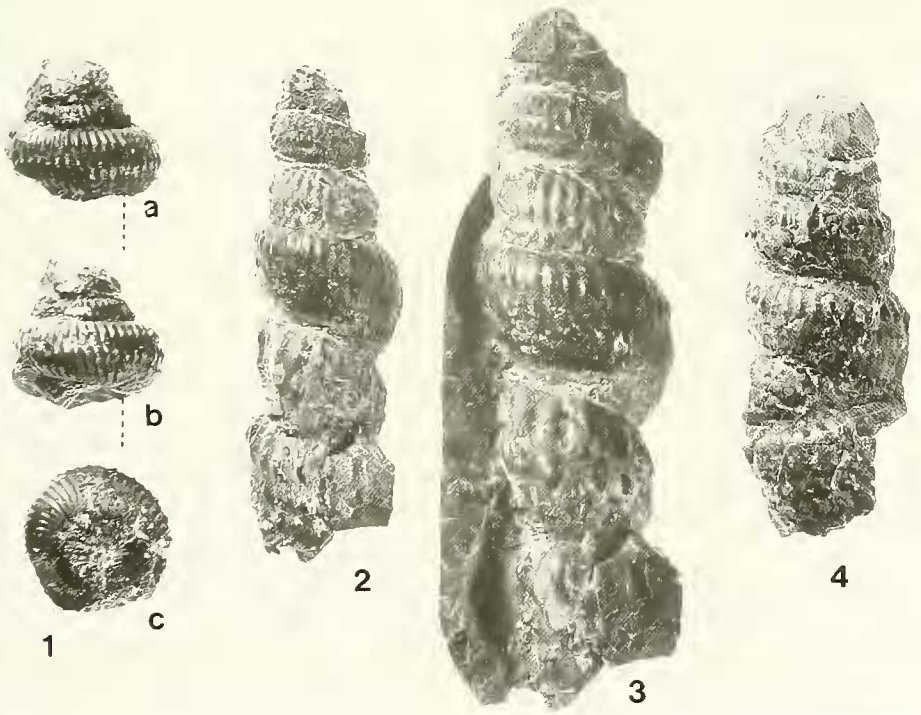

Figure 5. *Mariella* (*Mariella*) *gallienii* (Boule, Lemoin and Thévenin). **1.** GS. G189, two lateral (a, b) and basal (c) views, × 4/3. **2.** GS. G190, lateral view, ×1. **3.** GS. G190, lateral view before it is detached from the host rock, ×1.4. **4.** GS. G191, lateral view, ×4/3. (Photos by N. Egashira without whitening.)

(GS. G189), but in later stages the whorl becomes increasingly higher, with a weakly convex to nearly flat main flank and a rather oblong section. The ornamentation of these specimens is fundamentally similar to that of the first specimen (GS. G189), but the rib density (or the number of ribs per whorl) varies with growth and between individuals. The variation in the rib density and also in shell shape may be expressed by the columns Ribs and H/D in Table 3. Thus, the ribbing becomes less dense with growth. In GS. G190 the ornament is especially coarse on the loosely coiled last whorl (Figure 5-3).

Septal sutures are observable where the shell layer is taken away, as on the third whorl from the bottom in GS. G190.

Measurements.—See Table 3.

Comparison.—GS. G189 (Figure 5-1) is fairly similar to the lectotype (see above) of this species. Although the ribs are denser in the latter, the difference is by no means great (see Table 3). Our specimen is morphologically intermediate between the lectotype and paralectotype (Boule et *al*., 1907, pl. 7, figs. 4 and 5) from Madagascar.

The two whorls of the middle growth stage in GS. G190 and GS. G191 resemble those of MNHP R1073 from Madagascar described by Collignon (1931, pl. 9, fig. 16) and reillustrated by Wright and Kennedy (1996, text-fig. 134 L). Another specimen from the lectotype locality in Madagascar, illustrated by Collignon (1964, pl. 320, fig. 1379) and reillustrated by Wright and Kennedy (1996, text-fig, 134E) exemplifies a distinct change of relative whorl diameter at a certain young stage. This may support the presumed shape of the missing or poorly preserved young part of the three specimens (GS. G190-192) mentioned above.

Occurrence.—As for material. Outside Hokkaido, this species has been recorded in the Lower Cenomanian of Madagascar, South Africa and England (see references in the synonymy).

Discussion.—This species was entablished as a variety of *Ostlingoceras puzosianus*. This assignement has been revised by subsequent authors, as indicated in the synonymy list.

Klinger and Kennedy (1978, p. 29, pl. 3, figs. C, H, I; pl. 6, figs. B, D, O; pl. 7, figs. A, B; text-figs. 1E, 4E-G) established a subspecies *M*. (*M*.) *gallienii evoluta*, "which is characterized by loose coiling in which successive whorls are only slightly impressed." Although we have not looked at the actual specimen, the holotype of subspecies *evoluta* (*op. cit*., pl. 6, fig. C) does not seem to be so loosely coiled as the middle-to-late-stage of GS. G190 and G191. In our material the mode of coiling (loose or tight coiling) varies with growth and also between individuals. Moreover, the tightly coiled small specimen and larger ones with loosely coiled later whorls are contained in the same nodule. The Hokkaido material shows good conformity with that from Madagascar, which lay close to Zululand in mid-Cretaceous time. Some of the specimens from England (e.g., Wright and Kennedy, 1996, pl. 98, fig. 25) seems to show a rather loose coiling. A specimen from Zululand, donated to GK by Kennedy, is intermediate in the mode of coiling and rib density. For these reasons we are inclined to regard the subspecific separation as unnecessary and unnatural.

Table 3. Measurements of *Mariella* (*Mariella*) *gallienii* (Boule, Lemoine and Thévenin).

Specimen Whorl*	Diameter	Height	H./D.	Ribs
GS. G189 (1st)	10.2	3.4	.33	—
GS. G189 (2nd)	14.5	6.5	.45	46
GS. G190 (2nd)	13.5	6.8	.50	~36
GS. G190 (4th)	20.4	13.3	.65	42
GS. G191 (1st)	17.0	6.4	.38	~32
GS. G191 (2nd)	21.0	10.0	.48	34
GS. G191 (3rd)	23.0	13.5	.59	37
Lectotype	16.0	7.5	.47	50
GK specimen	19.0	10.5	.55	34

* The order in the column "Whorl" as for Table 1. Ribs: number of ribs per whorl; ~approximate number of ribs estimated from the measurable number in case of half whorl preservation. Lectotype is measured on the illustration in Boule et *al*., 1907, pl. 7, fig. 4a, b. GK specimen means an example from the Lower Cenomanian I at Skoenberg, Zululand, South Africa, kindly donated by W. J. Kennedy.

Concluding remarks

The genus *Mariella* of the Turrilitidae ranges from the Upper Albian to the Lower Cenomanian and includes a fair number of species. In these two successive papers altogether eight species of the subgenus *Mariella* (*Mariella*) from Hokkaido (northern Japan) have been described.

In Part 1 *M*. (*M*.) *dorsetensis* (Spath), *M*. (*M*.) oehlerti (Pervinquière) and *M*. (*M*.) *pacifica* Matsumoto, Inoma and Kawashita have been recorded to occur fairly commonly or very abundantly (the second species) in the Lower Cenomanian of the Soeushinai area (northwestern Hokkaido). *M*. (*M*.) *dorsetensis* and *M*. (*M*.) oehlerti are distributed worldwide in the Lower Cenomanian. They can be regarded as cosmopolitan elements of the fauna and are useful for interregional correlation. *M*. (*M*.) *pacifica*, which was established in Part 1, is so far endemic, but its wider distribution would be expected in view of its similarity to *M*. (*M*.) *torquatus* Wright and Kennedy and *M*. (*M*.) *numida* (Pervinquière) and its having some affinity with late Albian *M*. (*M*.) *camachoensis* (Böse).

The five species described in Part 2 are based on a rather small number of specimens, but they are interesting in creating some problems either in taxonomy or in stratigraphic occurrence. *M*. (*M*.) *bergeri* was obtained from the upper part of the Member My2 in the Soeushinai area, that is a correlative of the uppermost Albian. One of the specimens shows finely preserved spines. The second species tentatively called *M*. (*M*.) aff. *bergeri* is probably new for its particular characters. It came from the lower part of the Member My3, i.e., the basal Cenomanian. The third is identified with *M*. (*M*.) *miliaris* redefined by Atabekian (1985). It is based on three specimens which are inferred to have been derived from the Lower Cenomanian. The fourth is referred to *M*. (*M*.) cf. *carrancoi* (Böse). *M*. (*M*.) *carrancoi* is originally from the Upper Albian of Mexico, but our material

probably came from the Lower Cenomanian. The fifth is *M.* (*M.*) *gallienii* from the Lower Cenomanian. The subspecific separation of *M.* (*M.*) *gallienii gallienii* and *M.* (*M.*) *gallienii evoluta* may be unnecessary, for the reasons stated.

Acknowledgments

We are indebted to C.W. Wright and W.J. Kennedy for their kind help to this study. We appreciate the appropriate cooperations by Tamio Nishida, Katsujo Yokoi, Jun Aizawa and Naoko Egashira in the field and laboratory works. Kazuko Mori assisted us in preparing the manuscript.

References cited

Atabekian, A.A., 1985: Turrilitids of the late Albian and Cenomanian of the southern part of the USSR. *Academy of Sciences of the USSR, Ministry of Geology of the USSR, Transactions*, vol. 14, p. 1–112, pls. 1–34. (*in Russian*)

Böse, E., 1923: Algunas faunas Cretácicas de Zacatecas, Durango y Guerrero. *Instituto Geológico de México, Boletin*, no. 42, p. 1–219, pls. 1–19.

Boule, M., Lemoine, P. and Thévenin, A., 1907: Céphalopode crétacés des environs de Diégo-Suarez. *Annales de Paléontologie*, vol. 2, p. 1–58, pls. 1–8.

Breistroffer, M., 1947: Sur les zones d'ammonites dans l'Albien de France et d'Angleterre. *Travaux du Laboratoire de Géologie de la Faculté des Sciences de l'Université de Grenoble*, vol. 26, p. 1–88.

Brongniart, A., 1822: *In*, Cuvier, G. and Brongiart, A., *Description géologique des environs de Paris*, 428 p., 9 pls. Paris.

Chiriac, M., 1960: Reprezentanti ai Turrilitidae Meek, 1876 in Cretacicul Dobrogei de Sud. *Studii si Cercetari de Geologie*, vol. 3, p. 449–474.

Clark, D.L., 1965: Heteromorph ammonoids from the Albian and Cenomanian of Texas and adjacent areas. *Geological Society of America Memoir*, vol. 95, p. 1–99, pls. 1–24.

Collignon, M., 1931: Paléontologie de Madagascar, XVI. La faune du Cénomanien à fossiles pyriteux du nord de Madagascar. *Annales de Paléontologie*, vol. 20, p. 43–104, pls. 5–9.

Collignon, M., 1964: *Atlas des fossiles caractéristiques de Madagascar* (*Ammonites*). Fascicle 11 (Cénomanien). Service Géologique. Tananarive, p. 1–152, pls. 318–375.

Drushchits, V.V., 1960: Ammonites. *In*, Drushchits, V.V. and Kudriavtseva, M.P. eds., *Atlas of the Lower Cretaceous fauna of the northern Caucasus and the Crimea*, p. 249–355, pls. 1–22. (*in Russian*)

Förster, R., 1975: Die geologische Entwicklung von Süd-Mozambique seit der Unterkreide und die Ammoniten-Fauna von Unterkreide und Cenoman. *Geologisches Jahrbuch, Reihe B*, vol. 12, p. 1–324, pls. 1–17.

Kawabe, F., Hirano, H. and Takagi, K., 1996: Biostratigraphy of the Cretaceous System in the northern Oyubari area, Hokkaido. *Journal of the Geological Society of Japan*, vol. 102, p. 440–459, pls. 1–3. (*in Japanese with English abstract*)

Kennedy, W.J., 1996: Systematic palaeontology. *In*, Gale, A.S., Kennedy, W.J., Burnett, J.A., Caron, M. and Kidd, B.E.: The late Albian to early Cenomanian succession at Mont Risón near Rosans (Drome, SE France): an integrated study (ammonites, inoceramids, planktonic foraminifera, nannofossils, oxygen and carbon isotopes). *Cretaceous Research*, vol. 17, p. 543–590.

Klinger, H.C. and Kennedy, W.J., 1978: Turrilitidae (Cretaceous Ammonoidea) from South Africa, with a discussion of the evolution and limits of the family. *Journal of Molluscan Studies*, vol. 44, p. 1–48, pls. 1–9.

Kossmat, F., 1895: Untersuchungen über die Südindische Kreideformation. *Beiträge zur Paläontologie und Geologie Österreich-Ungarns und des Orients*, vol. 9, p. 97–203, pls. 15–25.

Matsumoto [Matumoto], T., 1942: Fundamentals in the Cretaceous stratigraphy of Japan. Part 1. *Memoirs of the Faculty of Science, Kyushu University, Series D, Geology*, vol. 1, no. 3, p. 129–280, pls. 5–20.

Matsumoto, T., 1967: Evolution of the Nostoceratidae (Cretaceous heteromorph ammonites). *Memoirs of the Faculty of Science, Kyushu University, Series D, Geology*, vol. 18, no. 2, p. 331–347, pls. 18–19.

Matsumoto, T., Inoma, A. and Kawashita, Y., 1999: The turrilitid ammonoid *Mariella* from Hokkaido — Part 1, with an Appendix by Matsumoto, T. and Nishida, T. *Paleontological Research*, vol. 3, no. 2, p. 106–120.

Matsumoto, T. and Nishida, T., 1999. Appendix. Locality guide for selected Cretaceous fossils of the Soeushinai area. *Paleontological Research*, vol. 3, no. 2, p. 116–119.

Nishida, T., Matsumoto, T., Kawashita, Y., Egashira, N., Aizawa, J. and Ikuji, Y., 1997: Biostratigraphy of the middle part of the Cretaceous Yezo Group in the Shumarinai area of Hokkaido — with special reference to the transitional part from Lower to Upper Cretaceous: supplement —. *Journal of the Faculty of Culture and Education, Saga University*, vol. 1, no. 1, p. 237–279. (*in Japanese with English abstract*)

Nishida, T., Matsumoto, T., Yokoi, K., Kawashita, Y., Kyuma, Y., Egashira, N., Aizawa, J., Maiya, S., Ikuji, Y. and Yao, A., 1996: Biostratigaphy of the Cretaceous Middle Yezo Group in the Soeushinai area of Hokkaido — with special reference to the transitional part from Lower to Upper Cretaceous —. *Journal of the Faculty of Education, Saga University*, vol. 44, p. 65–149. (*in Japanese with English abstract*)

Pictet, F.J. and Campiche, G., 1861; 1862: Description des fossiles du terrain Crétacé de environs de Sainte Croix, part 2. *Matériaux pour la Paléontologie Suisse, Series 3*, 1861, p. 1–144, pls. 44–57; 1862, p. 145–348, pls. 58–76.

Renz, O., 1968: Die Ammonoidea im Stratotyp des Vraconien bei Sainte Croix (Kanton Waadt). *Schweizerische Paläontologische Abhandlungen*, vol. 87, p. 1–97, pls. 1–18.

Roemer, F.A., 1852: *Die Kreidebildungen von Texas und ihre organischen Einschlüsse*. Adolf Marcus, Bonn. vi+100 p., 11 pls.

Scholz, G., 1979: Die Ammoniten des Vracon (Oberalb, *dispar*-Zone) des Bakony-Gebirge (Westungarns) und eine Revision der wichtigsten Vracon-Arten der West-Mediterranen Faunenprovinz. *Palaeontographica, Abt. A*, vol. 165, p. 1–136, pls. 1–30.

Seyed-Emami, K., 1982: Turrilitidae (Ammonoidea) aus den

Glaukonitkalk bei Esfahan (Zentraliran). *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, vol. 163, p. 417–434.

Spath, L.F., 1937 : A monograph of the Ammonoidea of the Gault, part 12. *Palaeontographical Society*, London, for 1936, p. 497–540, pls. 37–58.

Stoliczka, F., 1866 : Ammonitidae, with revision of the Nautilidae. *In*, Blanford, H.F. and Stoliczka, F. eds., The fossil Cephalopoda of the Cretaceous rocks of southern India. *Memoirs of the Geological Survey of India, Palaeontologia Indica, series 3*, vol. 1, p. 155–216, pls. 76–94.

Wiedmann, J. and Dieni, I., 1968 : Die Kreide Sardiniens und ihre Cephalopoden. *Palaeontographia Italica*, vol. 64, p. 1–171, pls. 1–18.

Wright, C.W. and Kennedy, W.J., 1996 : The Ammonoidea of the Lower Chalk, part 5. *Monograph of the Palaeontographical Society*, London, p. 320–403, pls. 95–124. (Publication no. 601, part of vol. 50 for 1996).